XLIX.—*Report of the Results of Researches in Physiological Botany made in the year* 1839. By F. J. Meyen, M.D., Professor of Botany in the University of Berlin*.

[Continued from p. 336.]

I have given a special description of the development of structure in the leaves of *Ficus elastica*†, and drew attention to some phænomena visible in this and in similar plants. I showed the development of the cuticular glands and their stomata, and found that the whole respiratory system, viz. the intercellular passages, with the more or less regular air-cells and respiratory cavities in the substance of the leaf, are first developed when the stomata make their appearance, and that as these are more fully developed the glandular hairs (which at an early stage are seen on the whole surface of the leaves of *Ficus elastica*) die off. All these subjects are fully explained by a series of drawings. The large masses of crystals which one finds in the large cells, chiefly under the epidermis of the upper surface of the leaves of *Ficus elastica*, are formed in a most peculiar manner on the surface of a club-shaped mass of gum, which is developed in the epidermal end of those large cells, and which grows downwards into the centre of the cell. These bodies, which I call for the sake of distinction "Gum-clubs" (gummikeulen), are of very different forms in the different species of *Ficus*; in some they are found only just under the upper surface, in others on the lower surface, and in some, indeed, they are found exclusively in that position. The delineations give the most exact description of the form, development, &c. of these formations. The species of the genus *Ficus* have generally firm and shining leaves, and the epidermis is then generally composed of several layers of cells; they are, however, all formed out of the outer layer which covers the leaf at the time when the formation of the cuticular glands and stomata commences; in one species a simple division of these cells takes place, in others the division is repeated, but one soon sees that all these layers belong together and form the true epidermis, on which account I should propose in such cases the name epidermal layer. It is thus explicable why the epidermal layer on the leaves of some species of *Ficus* have only two layers of cells, and that the layer on the lower surface, as, for instance, in *Ficus bengalensis*,

* Translated from the German, under the direction of the Author, and communicated by Henry Croft, Esq.

† Meyen's Beiträge zur Bildungsgeschichte verschiedener Pflanzentheile. —Müller, Archiv für Anatomie und Physiologie, &c., 1839, 255. mit 3 Quarttafeln.

Ficus pyriformis, consists of a single stratum of cells. We see by this that the type of formation remains the same in all the species of a genus, and that the modifications exhibited by different species in their structure are only to be explained by the more or less advanced degree of development; the same is seen in the hairs and glands on the leaves of the various species of *Ficus*; in some they remain during the whole life of the plants; in others, on the contrary, they fall off earlier or later.

At the same time I brought forward a series of examples, to show that in different plants and in different parts, cellular formations entirely different may be developed. The cell formation, on occasion of the development of the spores out of the original spore (motherspore), will be specially mentioned hereafter, as also the formation of the large cells by the appearance of transverse partitions in the embryo-sac of *Viscum album*; but besides these I mentioned the following cases:—During the formation of both cells of the cuticular glands, a longitudinal partition passes through the middle of the mucous nucleus, which is seen in the middle of the primitive cell of the future gland, and after the production of both cells a nucleus is formed in the middle of each of them. During the formation of the glands on the young leaves of *Ficus elastica*, I observed the radial arrangement of the cells lying near the primitive cell of the glands (mothercell); moreover, the further changes up to the perfect development of the gland with its stoma, the cavity belonging to it, &c. &c., were observed and delineated. In the club-formed and glandular hairs with which the young leaves of *Ficus* are covered, I observed that the formation of cells, by means of partitions, was preceded by separation or dissolution of the growing masses in the interior; but in some cases I saw that a partition passed through such a mass, and that sometimes cells were formed in the interior of the hair without the presence of such masses. In the tubes of *Mucor mucedo* I saw spiral formations as in the *Spirogyræ*, but in the case of Mucor they are colourless and extremely tender, and moreover not always present. Sometimes a portion of these spiral deposits separates from the sides and forms a bladder, which, at first, lies loose in the cavity of the tube, but afterwards attaches itself to the side, and partly causes its absorption, so that at last the new cell appears as a perfectly independent one connecting the neighbouring ends of the tubes.

Moreover, observations were made on the development of the *Ceramium diaphanum*, which are perhaps not altogether devoid of interest, but of which an extract cannot well be

given. Finally, the curious increase by continued regular division was explained in the case of that small Alga which I have denominated *Merismopedia punctata*, a plant which Ehrenberg has erroneously reckoned among animals. The regular position of the small ellipsoidal cells of this plant in fours instantly strikes the observer, and the propagation of these takes place by their regular division, which by observing different individuals may soon be seen in all its different stages. The new cells group themselves always in fours, and are surrounded by a tender gum-like substance.

In the Botanical Society of London* Mr. Daniel Cooper made known some experiments he had made to see whether coloured fluids entered into plants which were watered with them; the experiments were made without the author's being aware of what had been done previously. Three pots with large beans were taken, two were filled with mould and one with common sand, and all were watered with the same quantity of fluid, but the water which was used for the pot filled with sand was strongly coloured with madder. The result was that the coloured fluid did not pass into the plants, which were not at all changed by the operation. Mr. Cooper had placed one of the pots with mould in a dark place; he brought the grown-up plant into the light, and saw that the leaves first became lax and then died; and the same was the case with the other pot, which had been allowed to stand in the open air and was then brought into the dark; in this case also death finally ensued.

At the same time Mr. Cooper made known an observation of Mr. Wilkinson, who had observed that a potatoe which had fallen into a well twelve feet or more deep, grew out of it in order to reach the light. According to other observations, the length of a potatoe stalk grown in a cellar has been found to be twenty feet, on attaining which length it reached the window.

Phænomena of Generation in Plants.

1. *In the Phanerogamic Plants.*

In the former Report I could only give a very imperfect account of M. Wydler's† research on the formation of the embryo in the genus *Scrophularia*, for up to that time the treatise was unpublished. M. W. made his observations on

* Proceedings of the Bot. Society of London, &c. With Plates. London, 1839.

† Recherches sur la Formation de l'Ovule et de l'Embryon des Scrofulaires.—Bibliothèque Universelle de Genève, Oct. 1838.

Scrophularia nodosa, aquatica, betonicæfolia, peregrina, and *vernalis*; he first gives his observations on the formation of the placenta and of the ovulum, which agree with the ideas at present held on the subject. Until the formation of the integument the ovulum is straight, but it afterwards becomes bent. In *Scro. betonicæfolia* M. Wydler remarked that the nucleus as it protruded from its integument became hollow, and the cavity became covered with a membrane which represented the embryo-sac; but he could not distinguish whether this membrane was a new product, nor whether the cavity of the nucleus extended as far as the point; sometimes it could be distinctly seen that the end of the nucleus was closed. The description of the development of the stigma of the *Scrophularineæ* is also very clear and accurate; he states that the conducting tissue of the style is nothing more than the inner and modified epidermis of the involute fruit-leaf. M. Wydler observed the fructification to take place by means of a pollen-tube which entered into the micropyle; he also saw two or even four pollen-tubes enter at the same time, and correctly derives the appearance of several embryos from this circumstance, but adds that out of four young embryos only one comes to maturity. In regard to the act of fertilization, M. W. is evidently a follower of the new theory; but he admits that he has not been able to observe the action of the pollen-tube when it enters into the ovulum; but on this the whole hypothesis depends.

It seemed to M. W. that the embryo-sac was open at its end and communicated by a straight canal with the micropyle, for he often observed that the pollen-tube entered into the embryo-sac without this latter being indented. In the action of the seeds the presence of spiral fibres in the interior of the cells was observed; in a young state the cells contained grains of fecula, which vanished as the seeds became ripe, and here and there drops of oil made their appearance, and fibres were formed on the inner walls of the cells.

M. Wydler draws a number of conclusions from the above observation, in which I not only do not agree, but against which I can bring forward important facts. Concerning the hypothesis that there are not two sexes in plants, and that the anthers may be compared to the ovarium, we have spoken at full in the former Report and elsewhere; and M. W.'s observations on the changes which take place in the pollen-tube after its entrance into the nucleus are so imperfect, that we can draw no conclusion from them. M. Wydler has not been able to distinguish the pollen-tube from the supensor of the embryo; he speaks of the formation of cells in the former, but he evi-

dently means the suspensor of the embryo. All that I have said in the 3rd volume of my 'Vegetable Physiology' against Dr. Schleiden's theory of fertilization, applies in an equal degree to that of M. W., and I therefore refer my readers to the former Report, &c. &c.

Since then MM. Mirbel and Spach* have also opposed the theory of Schleiden; they have made observations on the development of the embryo in *Zea Mays*, and have confirmed the results thus obtained in many other grasses, as in *Euchlæna mexicana*, *Coix Lacryma*, *Tripsacum hermaphroditum*, *Sorghum vulgare*, &c. &c.

MM. Mirbel and Spach observed the complete development of the ovulum and the ovarium, and have given full descriptions accompanied by figures; they consider the formation of the above-mentioned cavity as the first appearance of the embryo-sac in the end of the nucleus, and call the gum contained therein "amorphous cambium." Finally, the transparency of this gum disappears, and in the cavity of the nucleus there is seen a proportionately large tube, egg-shaped and transparent; this was called "utricule primordiale;" at the upper end (chalaza end) it is furnished with a slender elongation, on which small cells are fastened in the form of a compound raceme; at the lower end it terminates in a thread-shaped tubular appendage, which extends into the endostomium, and may be compared to the suspensor in other plants. It is shown that this primordial or primitive tube is not produced by a depression of the embryo-sac, for the *Gramineæ* have no embryo-sac at all.

Soon after the appearance of the primitive tube they remarked in it the formation of a "cambium globulo-cellulaire," which consisted of globules, in each of which there is a central cavity. This cambium forms finally a mass of cellular tissue, which fills the cavity of the tube and the supporter, which latter becomes larger and longer. This primitive tube being filled with cellular tissue is the young embryo, which, as the authors say, no one will doubt; the upper end thickens, spreads itself out like a blunt-headed lance and becomes the hypoblast of Richard, while the lower end exhibits for some time the lax thread or supporter. These gentlemen have convinced themselves long since that the formation of the primitive tube takes place before the action of the pollen, and that it is quite independent, that it is produced *in* the nucleus and does not descend into it. Schleiden evidently took this

* Notes pour servir à l'Histoire de l'Embryogénie Végétale.—Compt. Rend., Mars, 1839; Annales des Sc. Nat. 1839, I.

tube for the end of the pollen-tube which had penetrated into the nucleus.

The raceme of small cells which crowns the primordial tube at the upper end has been overlooked by Schleiden, and MM. Mirbel and Spach state them to be abortive primordial tubes.

The results of the observations are too evident to require any very full explanation. According to them, the fertilization of *Zea Mays* takes place neither according to the new nor the old theory: the observations are quite unfavourable to the new view; for the tube which produces, or is changed into the embryo, does not come into the nucleus from without, but is formed in it and at a distance from the pollen. How the fertilization takes place, MM. Mirbel and Spach show they are quite ignorant. The observations of these gentlemen were so very different from my own former ones, that I was obliged to convince myself of their correctness*. I examined the female flowers of the *Zea Mays*, and not only found the above discoveries perfectly correct, but was fortunate enough to be able to add some new observations. I saw that the extremity of the primitive tube was always closed and never in communication with the pollen-tube; the primitive tube becomes embryo, and out of the ovoid cells at the lower (chalaza) end is produced the scutellum, which grows more or less over the whole embryo in the form of a folding leaf; out of the small lower cleft of this scutellum there hangs the radicular end of the embryo, and exhibits the half lifeless string of cells which formed the supporter at the end of the primitive tube. I have often succeeded in extricating the little embryo from the imperfectly formed scutellum.

Afterwards M. Mirbel† acknowledged that his discovery of the primitive tube, out of which the embryo was formed, was erroneous; he convinced himself that this utriculus is the true embryo-sac in which the embryo and the albuminous body are formed; and according to this also the error into which I have fallen must be corrected; it was caused by my trusting more to these observations than to my own, which had been made previously.

[To be continued.]

* Meyen, Noch einige Worte uber den Befruchtungsakt und die Polyembryonie bei den höheren Pflanzen. 2 Steintafeln. Quarto. Berlin, 1840. p. 21.

† Rectification d'une erreur commise dans les "Notes pour servir à l'Histoire de l'Embryogénie Végétale."—Annales des Sci. Nat., Avril, 1839. Part. Bot. i. p. 381.